N91-28266

BUSINESS NOT AS USUAL

Presented to
Program Development and
Cultural Issues Panel
at the
Space Transportation Propulsion
Systems Symposium

June 27, 1990

Pratt & Whitney

Don Connell

CONCLUSION

Manage the problems
together (Government/Contractors)

Don't resist cultural change

TYPICAL DESIGN SIMPLIFICATION IDEAS WHICH REDUCE COSTS

ELIMINATE BOOST PUMPS

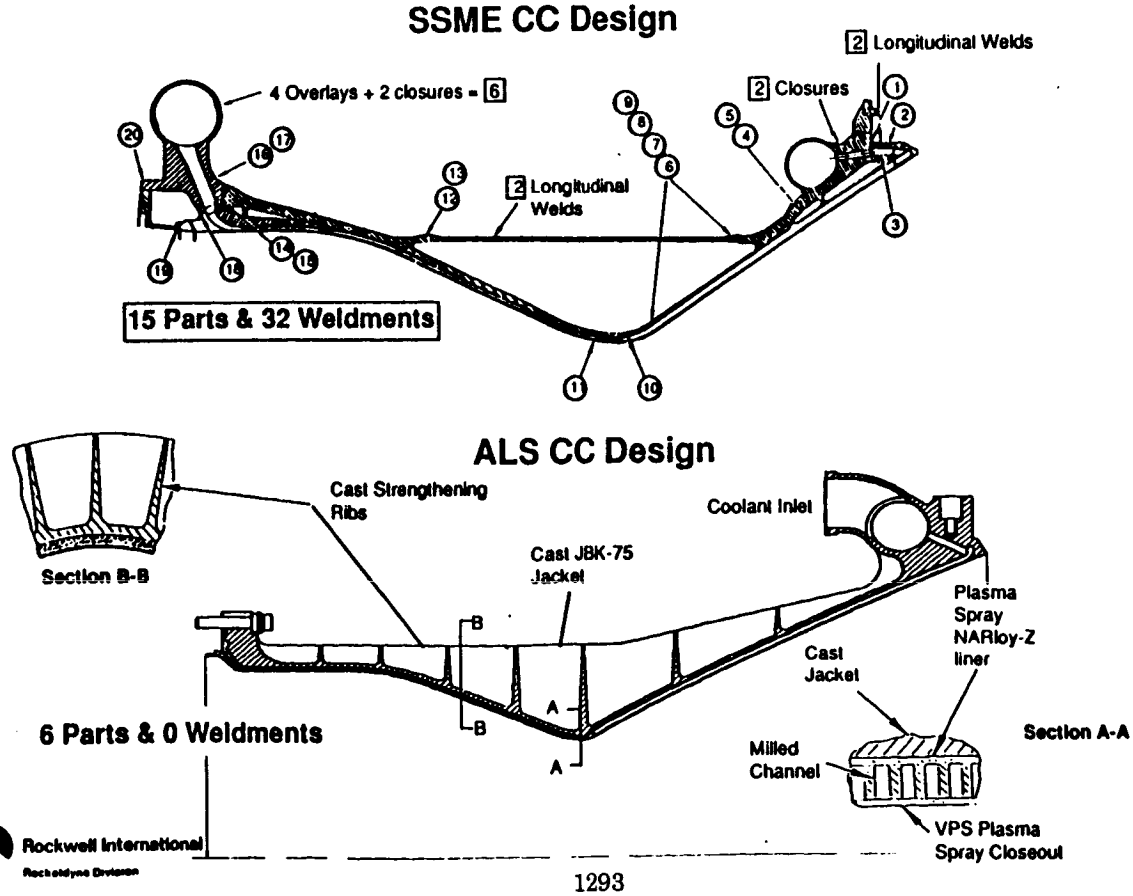
ELIMINATE FAIL-OP IN CONTROL SYSTEM

ELIMINATE THROTTLING AND CLOSED LOOP CONTROL

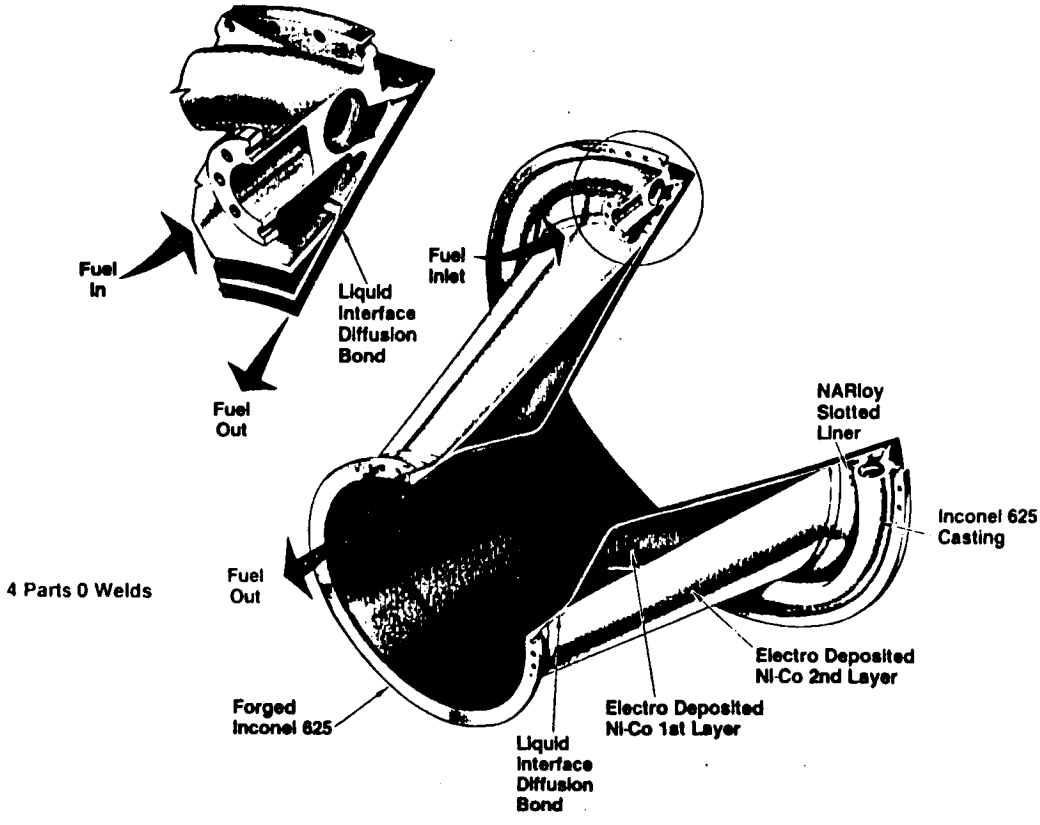
LOWER CHAMBER PRESSURE

ELIMINATE POWER HEAD/DUAL PREBURNERS (GG CYCLE)

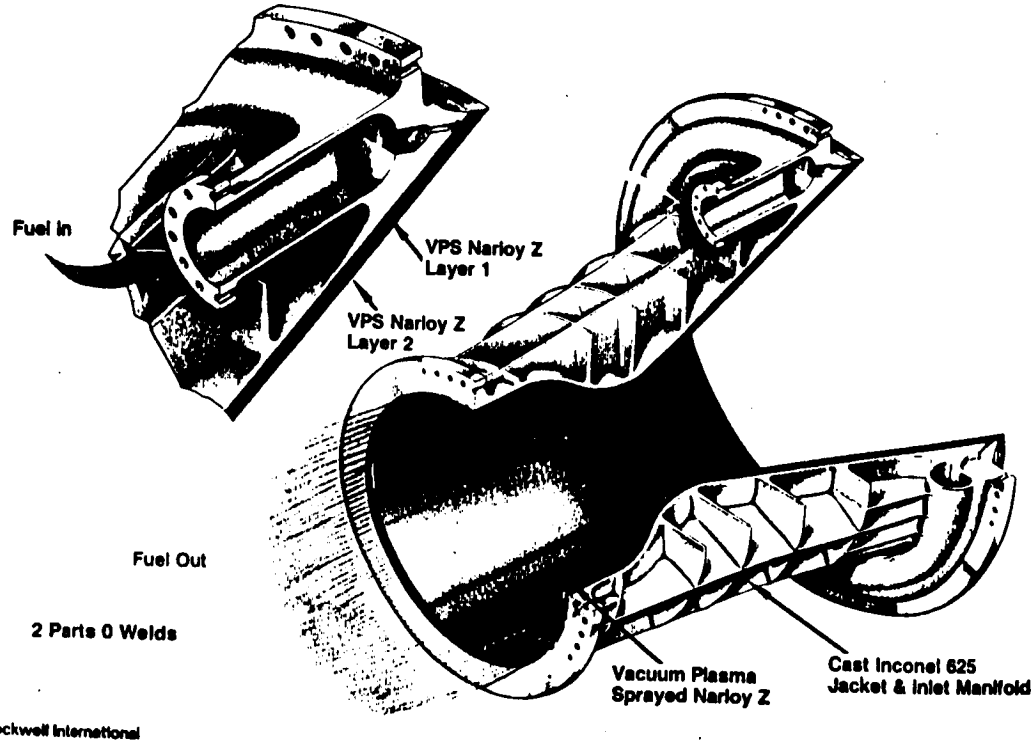
COMBUSTION CHAMBER DESIGN SIMPLIFICATION



BASELINE – 1A COMBUSTION CHAMBER

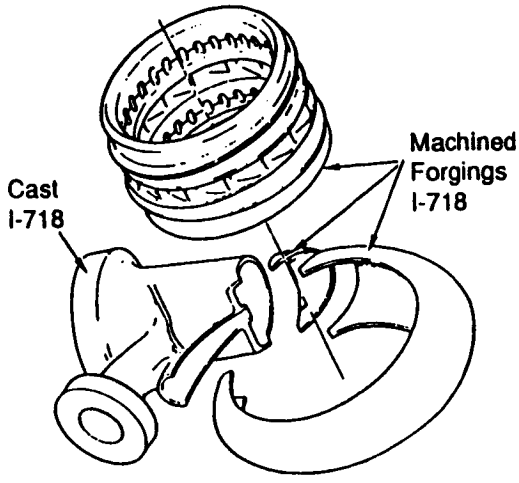


BASELINE – 1B COMBUSTION CHAMBER

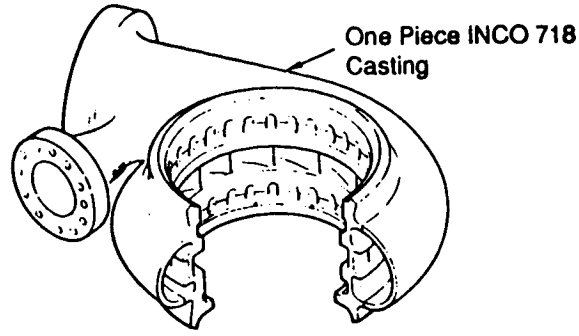


Rockwell International

CASTINGS VS. MACHINED AND WELDED FORGINGS



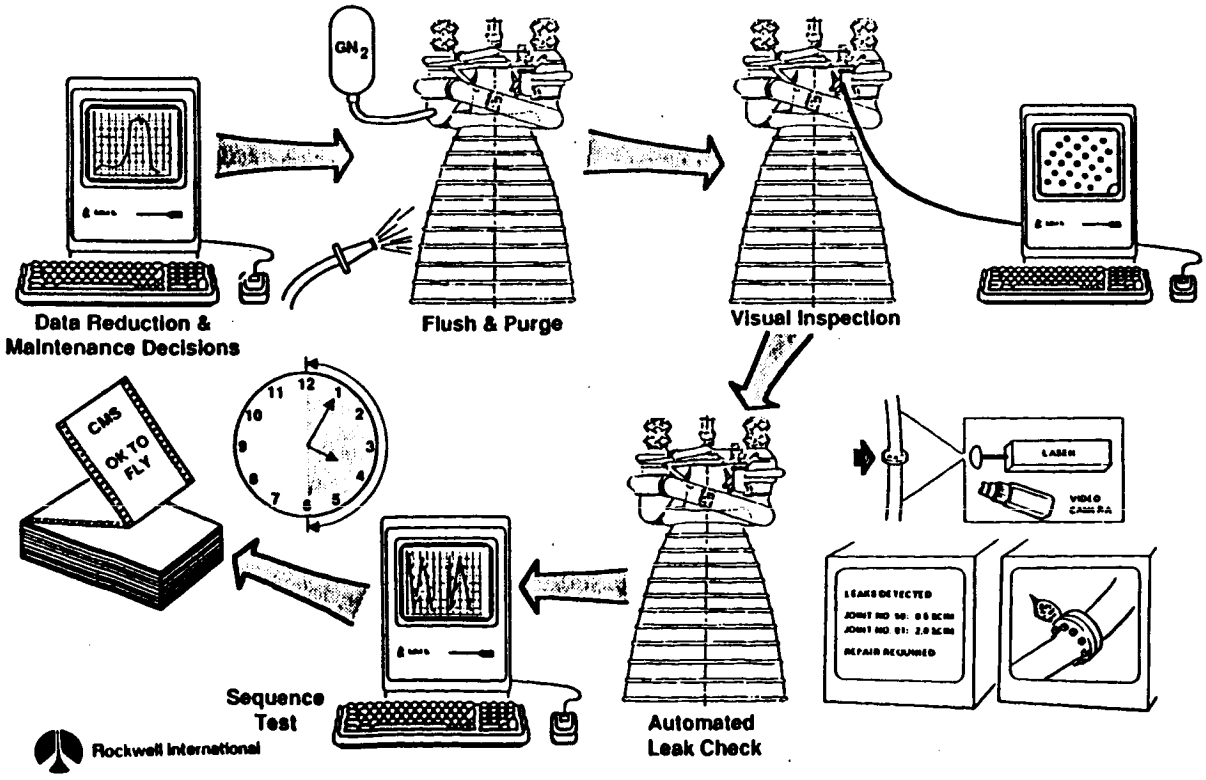
SSME Turbopump Volute



IR&D Cast Volute

Cost Savings of >10:1

AUTOMATED INSPECTIONS AND FUNCTIONAL CHECKS



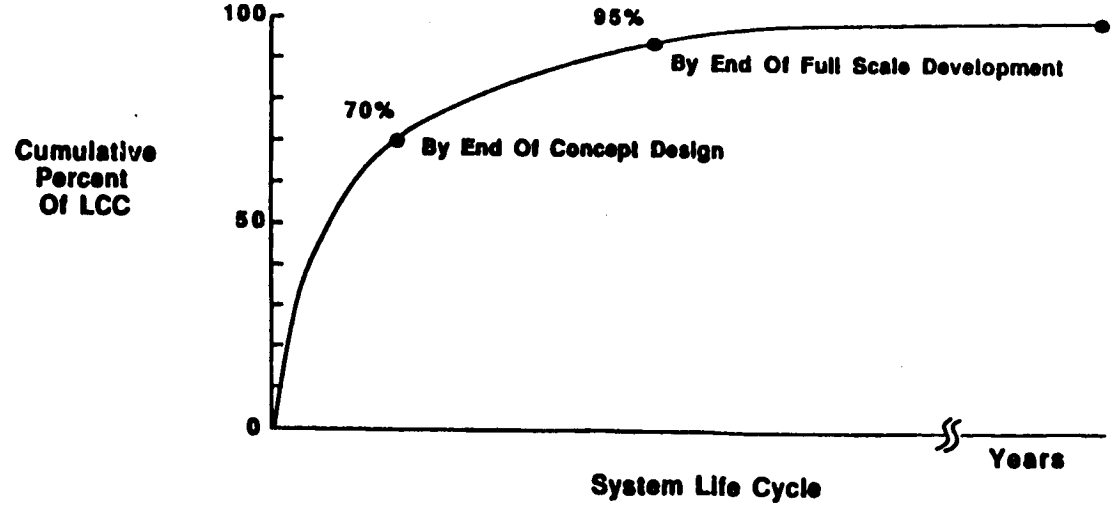
Aerojet Propulsion Division

Roy Michel

GENCORP AEROJET

Propulsion Division

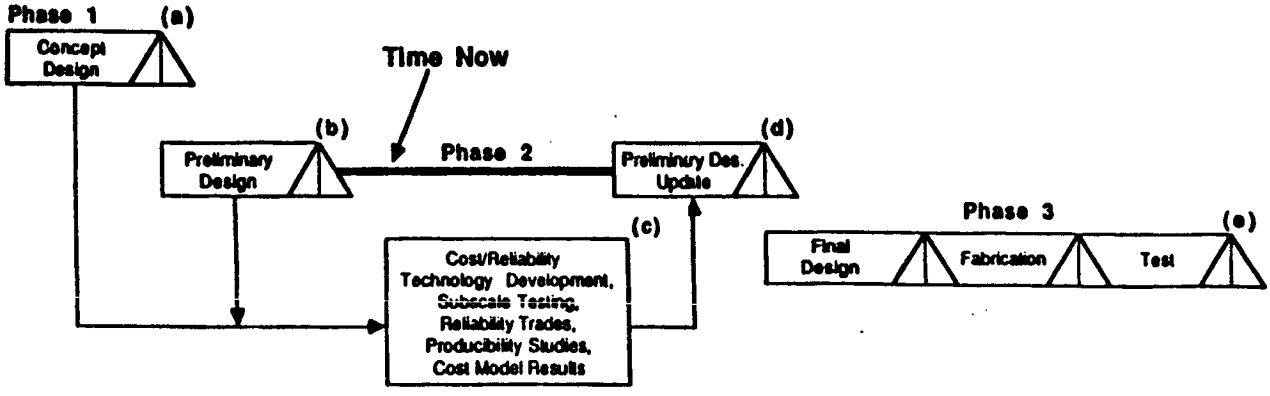
Two Thirds Of Total Life Cycle Cost Is Determined By The End Of Concept Design*



* Richman Associates, Design To Cost Seminar, Aerojet 1977

Our Approach To The TCA: Maintain Flexibility

- Establish A Point Of Departure Design (a)
- Evaluate Competing Low Cost Designs/Approaches (b)
- Examine Technical And Process Issues And Alternatives (c)
- Select Final Approach Based On Rigorous Cost Comparisons (d)
- Demonstrate The Final Concept At MSFC (e)



Our Cost Model Embodies TQM

QFD	Respond To Customer's Desire For: • Low Cost Design • Understanding Of Factors Affecting Cost
Juran	Identify Avoidable And Unavoidable Costs
	Evaluate, Early In The Design Process:
TQM	Form: Touch Labor And Material Costs To Manufacture The Hardware
SPC	Fit: Manufacturing Process Yields
Taguchi	Function: "Warranty" Costs - Reliability And Spares

Summary

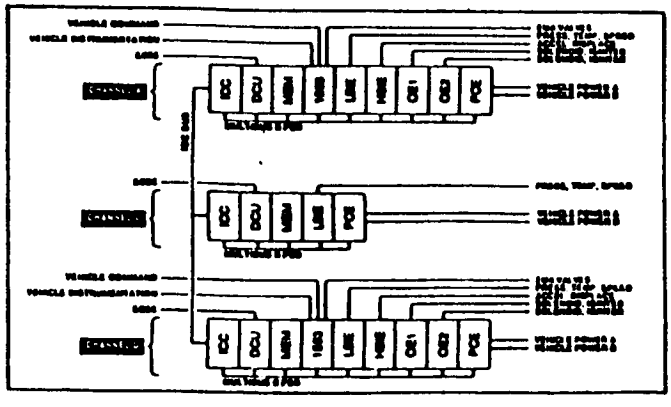
- High Reliability And Low Cost Are Obtainable
  - Inherent In Design And Manufacturing Processes:

Fewer Parts	Advanced Processes
Low Cost Materials	Reduced Inspection
Wider Margins	Efficient Manufacturing

- Contractors Are Committed
- TQM Is In
- Consortium + Government + Prime Contractors = Partnership
- Government Role Is Key
  - Fix The Requirements
  - Avoid Gold Plating
  - Limit Specifications
  - Maintain Funding And Schedule

Low Cost Approaches To Engine Controller

- Modular, Flexible Architecture Results In 70% Decrease In Controller Life Cycle Cost
- Standard Modules, Interfaces, Software
- Adaptable To Various Engine Requirements



Low Cost Approaches To Propellant Control Effector

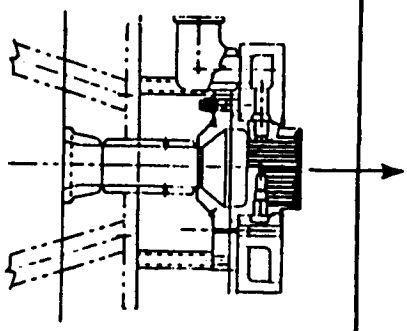
- Electromechanical Activation
- Ox And Fuel Valve Commonality
- Integral Electronics
- Digital Control And Interface
- Integral Valve Position Resolver

Low Cost Approaches To Turbopump Design

- Two-Stage Pump
- Self-Compensating Hydrostatic Bearings
- Cast Turbine Manifold
- Cast Pressure Vessel
- Integrally Machined Turbine Hub And Blades (Blisk)
- LCF And HEE-Resistant Turbines
  - No Coatings Or Platings
- Cast Impellers
- Reusable With Minimum Inspection And Refurb

Injector Assembly and Subscale Chambers Will Provide the Data Base for the 3-D Subscale Impinging Injector

Workhorse Chamber



- w/wo Ablative Stability Ring
  - Bomb Testing
- Long Duration Tests
  Performance Testing

Calorimetric Chamber

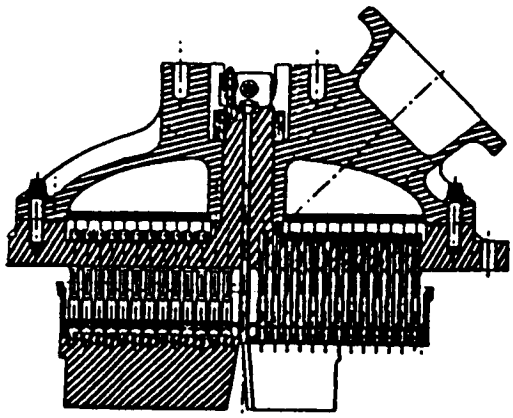
w/wo L* Section
Heat Flux Profile
FFC Effects

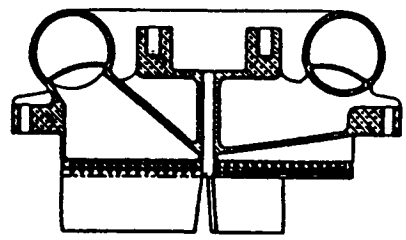
L*
Ablative Chamber

Nozzle

- Stability Demonstration
  - Bomb
  - Fuel Temperature
  - Chug

Impinging Element Injector Offers Lower Cost and Acceptable Isp





Parameter		Baseline Swirl Coax Element	Alternative Impinging Element
# Parts		2200	15
# Operations		133	67
Injection ΔP_{FUEL}	(Psi)	340	340
Injection ΔP_{OXID}	(Psi)	515	340
Predicted Isp	(sec)	441.7	438.5

Concurrent Engineering Design Approach Addresses All Major Design Objectives

- Downstream Functions Actively Participated In The Design Process

Suppliers	Reliability
Producibility	Safety
QA	ILS

- Approach To High Reliability Formulated
- Approach To Low Cost Formulated
- Cost Model Constructed

Ongoing Advanced Development Programs Are Focused On High Reliability And Low Cost

- Combustion Devices
  - Thrust Chamber Assembly
  - Gas Generator Assembly
- Hydrogen Turbopump Assembly
- Propellant Control Effector (GGA Valve)
- Engine Controller